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SCIENCE

NEW SERIES
VOL. XLIX No. 1253

FRIDAY, JANUARY 3, 1919

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SCIENCE

FRIDAY, JANUARY 3, 1919

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THE PROBLEM OF RADIOACTIVE LEAD[1]

WE meet to-day with happiness which six months ago would have seemed beyond the bounds of reasonable hope. After anxious months, the confidently awaited victory, which last spring still seemed far away, has crowned the cause of justice, truth and liberty. We in America rejoice that this cause is our cause, and that at the most critical time we were able to render effective help to the staunch and brave allied forces which had fought so long and so nobly.

The object of this address is not, however, to appraise the military issues of the great war so fortunately ending, nor to deal with the weighty international problems now faced by the world, but rather to bring before you other considerations, having to do with the advancement of science.

The particular subject chosen, namely, the problem of radioactive lead, is one of peculiar and extraordinary interest, because it involves a readjustment and enlargement of many rather firmly fixed ideas concerning the chemical elements and their mutual relations, as well as the nature of atoms.

Within the last twenty years the definition of these two words, "elements" and "atoms," has been rendered somewhat uncertain, and bids fair to suffer even further change. Both of them are ancient words, and both even a century since had acquired meanings different from those of long ago. Thales thought of but one element, and Aristotle's elements—earth, air, fire, water and the quintessence, derived perhaps from yet more ancient philosophy—were not plentiful enough to account for all the manifold phenomena of nature. Democritus's old idea of the atom was asso-

[1] Address of the President of the American Association for the Advancement of Science, Baltimore, December, 1918.

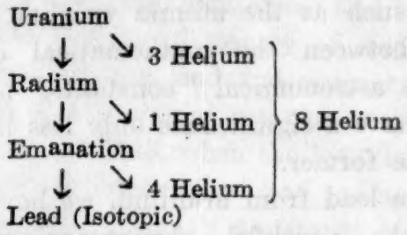
ciated rather with the philosophical conception of indivisibility than with the idea of chemical combination in definite proportions. To-day many chemists and physicists think that the chemical atoms of the last century are no longer to be considered as indivisible. In that case, the old Greek name "atom" is no longer fitting, because it denotes indivisibility. Some one has even facetiously suggested that the word "tom"—indicating divisibility—would be more appropriate! Moreover, if our so-called atoms are really divisible, we can not but be somewhat doubtful as to our definition of the ultimate elements of the universe. The reason for this new turn of thought is due, as you all know, to the discovery of the unexpected and startling phenomena of radioactivity.

To-night we have to deal with a substance directly concerned with the iconoclastic radioactive changes—with the very phenomena which cause us to stop and think about our definitions of atoms and elements. For the lead obtained from radioactive minerals appears to have resulted, together with helium, from the radioactive decomposition of elements of higher atomic weight. Skeptical at first, the whole chemical world has now come to acknowledge that the well-defined element, helium (discovered by Sir William Ramsey twenty-three years ago), is one of the decomposition products of radium. Radium itself is a substance which, in many respects, acts as an element, with 226 as its atomic weight, and must be considered as the heaviest member of the well-known calcium family; but its atoms appear to be so big and so complex as to disintegrate because of lack of stability. The disintegration is slow, and not to be hastened or retarded by any agency known to man; 1,670 years are demanded for the decomposition of half of any given portion of radium, according to the exact measurements of Professors Boltwood and Ellen Gleditsch. Moreover, we have reason to believe that this decomposition proceeds in a series of stages, successive atoms of helium (five in all) being evolved with different degrees of ease by any given atom of radium. In the end most, indeed probably all, of the residual part of the radium appears to have been converted into the peculiar kind of metallic lead with which we are concerned to-night. The nature of the end-product was first suggested by Boltwood, who pointed out the invariable presence of lead in radium minerals. Thus we must accept a kind of limited transmutation of the elements, although not of the immediately profitable type sought by the ancient alchemists.

Interesting and significant as all of this is, nevertheless the whole story has not yet been told. Radium itself appears to come from the exceedingly slow decomposition of uranium, an inference drawn from the fact that radium is found only in conjunction with the uranium, which even after careful purification soon becomes radioactive and gives every indication of suffering slow disintegration. Moreover, uranium is not the only other heavy element which appears to be capable of decomposing and yielding elements of lower atomic weight. Another, thorium, has a like propensity, although the steps in this case are perhaps not so fully interpreted, nor so generally accepted. In the process of disintegration all these heavy atoms yield strange radiations, some of them akin to, or identical with X-rays, which bear away that part of the colossal energy of disintegration not made manifest as heat. These facts have been proved beyond doubt by the brilliant work of Madame Curie, Sir Ernest Rutherford, and others.

The nature of the rays, and of the highly interesting evanescent transition products and their relation to one another is too complex for discussion now. We are concerned rather with the nature of the more permanent of the substances concerned—especially with the starting point, uranium (possessing the heaviest of all atoms), radium, and the lead which seems to result from their disintegration. Omitting the less stable transition products, the most essential outcomes are roughly indicated by a sort of genealogical tree herewith shown:

HYPOTHESIS CONCERNING THE DISINTEGRATION OF URANIUM



Thus each atom of uranium is supposed to be converted into radium by losing three atoms of helium, and each atom of radium is supposed to be converted into a kind of lead by losing five more, as already stated.

If uranium can thus disintegrate, should we call it an element? and should we call its smallest particles atoms? The answers depend upon our definition of these two words. If the word "element" is supposed to designate a substance incapable of disintegration, apparently it should not be applied to uranium; neither should the word "atom" be applied to the smallest conceivable particles of this substance. But no one would now maintain that any element is really incapable of disintegration. A method of still retaining the terms in this and analogous cases is to define an element as "a substance which has not yet been decomposed artificially," that is to say, by the hand of man—and an atom as "the smallest particle of such a substance, inferred from physicochemical behavior." The atom, then, is not to be considered as wholly indivisible, but only as indivisible (or at least, as not yet divided) by artificial means. For, as in the case of radium, the disintegration of uranium can not be hastened or retarded by any known earthly agency. So long as it stays intact, the atom of uranium behaves quantitatively in the same fashion as any other atom: Dalton's laws of definite and multiple combining proportions apply without exception to its compounds. In this connection one should remember that the atomic theory, as a whole, including Dalton's and Avogadro's generalizations, is not in the least invalidated by the new discoveries of radioactivity. On the contrary, the atomic theory is entrenched to-day more firmly than ever before in its history.

Interesting speculations by Drs. Russell, Fleck, Soddy and Fajans and others have interpreted in extremely ingenious and plausible fashion the several transitory steps of the changes, and indicate the reasons why the end-products of the decomposition both of uranium and thorium should be very similar to lead, if not identical with it. Therefore a careful study of the properties of lead of indubitably radioactive origin became a matter of great interest, as a step toward confirming these speculations, especially in comparison with the properties of ordinary lead. Such investigations should throw light on the nature of radium and uranium and the extraordinary changes which those metals suffer. Moreover, by analogy, the resulting conclusions might be more or less applicable to the relations of other elements to each other; and the comparison of this new kind of lead with ordinary lead might afford important information as to the essential attributes of elementary substances in general, in case any differences between the two kinds should be found.

Before the subject had been taken up at Harvard University, chemists had already recognized the fact that the so-called uranium-lead is indeed qualitatively very like ordinary lead. It yields a black sulphide, a yellow chromate, and a white sulphate, all very sparingly soluble in water, just as ordinary lead does. Continued fractional crystallization or precipitation had been shown by Professor Soddy and others to separate no foreign substance. Hence great similarity was proved; but this does not signify identity. Identity is to be established only by quantitative researches. Plato recognized, long ago, in an often-quoted epigram, that when weights and measures are left out, little remains of any art. Modern science echoes this dictum in its insistence on quantitative data; science becomes more scientific as it becomes more exactly quantitative.

One of the most striking and significant of the quantitative properties of an element is its atomic weight—a number computed from

the proportion by weight in which it combines with some other element, taken as a standard. There is no need, before this distinguished audience, of emphasizing the importance of the familiar table of atomic weights; but a few parenthetical words about their character is perhaps not out of place. As has been more than once said, the atomic weights of the relatively permanent elements, which constitute almost all of the crust of the earth, seem to be concerned with the ultimate nature of things, and must have been fixed at the very beginning of the universe, if indeed the universe ever had any beginning. They are silent, apparently unchanging witnesses of the transition from the imagined chaos of old philosophy to the existing cosmos. The crystal of quartz in a newly hewn piece of granite seems, and probably is, as compact and perfect as it was just after it was formed, eons ago. We can not imagine that any of its properties have essentially changed during its protracted imprisonment; and, so far as we can guess, the silicon and oxygen of which it was made may have existed for previous eons, first as gas, and then as liquid. The relative weights in which these two elements combine must date at least from the inconceivably distant time when the earth "was without form and void."

Although, apparently, these numbers were thus determined at the birth of our universe, they are, philosophically speaking, in a different class from the purely mathematical constants such as the relation of circumference to the diameter of a circle. 3.14159 . . . is a geometrical magnitude entirely independent of any kind of material, and it therefore belongs in the more general class of numbers, together with simple numerical relations, logarithmic and trigonometric quantities, and other mathematical functions. On the other hand, the atomic weights of the primeval elements, although less general than these, are much more general and fundamental than the constants of astronomy, such as the so-called constant of gravity, the length of the day and year, the proper motion of the sun, and all the other incommensurable magnitudes which have been more or less accidentally ordained in the cosmic system. The physicochemical constants, such as the atomic weights, lie in a group between the mathematical constants and the astronomical "constants," and their values have a significance only less important than the former.

In the lead from uranium, we have a comparatively youthful elementary substance, which seems to have been formed since the rocks in which it occurs had crystallized. Is the atomic weight of this youthful lead identical with that of the far more ancient common lead, which seems to be more nearly contemporary as to its origin with the silicon and oxygen of quartz?

The idea that different specimens of a given element might have different atomic weights is by no means new—it far antedates the discovery of radioactivity.

Ever since the discovery of the definite combining proportions of the elements and the ascription of these proportions to the relative weights of the atoms, the complete constancy of the atomic weights has occasionally been questioned. More than once in the past investigators have found apparent differences in the weights of atoms of a single kind, but until very recently all these irregularities have been proved to be due to inaccurate experimentation. Nevertheless, even thirty years ago the question seemed to me not definitively answered, and careful experiments were made with copper, silver and sodium, obtained from widely different sources, in the hope of finding differences in the atomic weights, according to the source of the material. No such differences whatever were found. More recently Professor Baxter, of Harvard, compared the atomic weights of iron and nickel in meteorites (from an unknown, perhaps inconceivably distant source) and the same terrestrial metals. In these cases also the results were negative. Thus copper, silver, sodium, iron and nickel all appeared to be perfectly definite in nature, and their atoms, each after its own kind, all alike.

The general question remained, nevertheless, one of profound interest to the theoretical

chemist, because it involved the very nature of the elements themselves; and in its relation to the possible discovery of a difference between uranium lead and ordinary lead, it became a very crucial question.

Early in 1913, when the hypothesis of radioactive disintegration had assumed definite shape, Dr. Fajans's assistant, Max Lembert, journeyed to Cambridge, bringing a large quantity of lead from Bohemian radioactive sources, in order that its atomic weight might be determined by Harvard methods, with the precision attainable there. The Carnegie Institution of Washington gave generous pecuniary assistance toward providing the necessary apparatus, in this and subsequent investigations.

The most important precautions to be taken in such work are worthy of brief notice, because the value of the results inevitably depends upon them. The operation consists in weighing specimens of a salt of the element in question, and then precipitating one of the constituents in each specimen, determining the weight of the precipitate, and thus the composition of the salt. In the first place, each portion of substance to be weighed must be free from the suspicion of containing unheeded impurities, otherwise its weight will mean little. This is an end not easily attained, for liquids often attack their containing vessels and absorb gases, crystals include and occlude solvents, precipitates carry down polluting impurities, dried substances cling to water, and solids, even at high temperatures, often fail to discharge their imprisoned contaminations. Especial care was taken that each specimen was as pure as it could be made, for impurity in one would vitiate the whole comparison.

In the next place, after an analysis has once begun, every trace of each substance to be weighed must be collected and find its way in due course to the scale pan. The trouble here lies in the difficulty in estimating, or even detecting, minute traces of substances remaining in solution, or minute losses by evaporation at high temperatures.

In brief, "the whole truth and nothing but the truth" is the aim. The chemical side of the question is far more intricate and uncertain than the physical operation of weighing. The real difficulties precede the introduction of the substance into the balance case. Every substance must be assumed to be impure, every reaction must be assumed to be incomplete, every measurement must be assumed to contain error, until proof to the contrary can be obtained. Only by means of the utmost care, applied with ever-watchful judgment, may the unexpected snares which always lurk in complicated processes be detected and rendered powerless for evil.

After all these digressions, made in order that the problems concerned should be clearly recognized, let us turn to the main object of our quest. In the present case, each form of lead was first weighed as pure chloride, and the chlorine in this salt after solution was precipitated as silver chloride, the weight of which was determined. Precautions too numerous to mention were observed. Thus the weight of chlorine in the salt was found, and by difference the weight of the lead. From the ratio of weights, the atomic weight of lead was easily calculated.

The outcome of the first Harvard trials, published in July, 1914, brought convincing evidence that the atomic weight of the specimen of uranium-lead from Bohemia is really less than that of ordinary lead, the value found being 206.6, instead of 207.2—a difference of 0.3 per cent., far beyond the probable error of experiment. Almost simultaneously preliminary figures were made public by Drs. Hönigschmid and St. Horovitz and Maurice Curie, pointing toward the same verdict.

This result, interesting and convincing as it was, was only a beginning. Other experimenters abroad have since confirmed it, especially Professor Hönigschmid, who had studied at Harvard and understood the necessary refinements of analysis; and many new determinations have been made at the Wolcott Gibbs Memorial Laboratory, with the assistance of Dr. Charles Wadsworth, 3d, and Dr. Norris F. Hall, upon various samples of lead

from radioactive sources in widely separated parts of the world. Messrs. E. R. Bubb and S. Radcliff, of the Radium Hill Company, of New South Wales, kindly sent a large quantity of lead from their radium mines, and a particularly valuable specimen prepared from selected crystals of pure mineral was put at our disposal by Professor Gleditsch—not to mention other important contributions from others, including Professor Boltwood and Sir William Ramsay. Each of these samples gave a different atomic weight for the lead obtained from them, and the conclusion was highly probable that they contained varying admixtures of ordinary lead in the uranium-radium-lead. This was verified by the knowledge that in at least some cases the uranium ore actually had been contaminated with lead ore. The purest Norwegian specimen thus acquired especial importance and significance, because it was only very slightly, if at all, vitiated in this way. As a matter of fact, it gave 206.08 for the atomic weight in question—the lowest of all. Here are typical results, showing the outcome; many more of similar tenor were obtained.

ATOMIC WEIGHTS

Common lead	207.20 207.19	207.19
Australian Radioactive Lead containing probably 25 per cent. ordinary lead	206.32 206.36 206.33 206.36	206.34
Purest Uranic-lead	206.08 206.09	206.08

Hönigschmid, from similar pure material, had found figures (206.05) agreeing almost exactly with the last value. One can not help believing that this last specimen of lead is a definite substance, probably in a state almost pure, because of the unmixed quality of the carefully selected mineral from which it was obtained.

A further question now arises: is it a *permanent* substance—really an end-product of the disintegration? Soddy's hypothesis assumes that it is. The only important fact militating against this view is the observation that uranium-lead is always radioactive, and hence might be suspected of being unstable. In various impure specimens, however, the radioactivity is not proportional to the change in the atomic weight; hence the radioactivity is probably, at least in part, to be referred not to the lead itself, but rather to contamination with minute, unweighable amounts of intensely radioactive impurities—other more transitory products of disintegration.[2] If weighable, such impurities would almost certainly *increase,* not *diminish,* the atomic weight; hence their presence could not account for the low value.

Let us compare the actual result for the atomic weight of this kind of lead with the theory of Soddy and Fajans. If this theory is sound, the simple subtraction of eight times the atomic weight of helium from that of uranium, or five times the atomic weight of helium from that of radium, should give the atomic weight of the lead resulting from the disintegration, as follows:

HYPOTHETICAL CALCULATION OF ATOMIC WEIGHT OF URANIUM-LEAD

Atomic weight of uranium	= 238.18		
8 × atomic weight of helium	= 32.00		
Residue (lead?)	206.18	=	206.18
Atomic weight of radium	= 225.96		
5 × atomic weight of helium	= 20.00		
Residue (lead?)	205.96	=	205.96
Average hypothetical value for lead		=	206.07
Observed value for uranium-lead[3]		—	206.08
Difference			0.01

The agreement is remarkably good. Each of the individual calculated values shows less than 0.05 per cent. deviation from the average, and the average itself shows essential identity with fact—a striking confirmation of the theory. This is perhaps the most successful

[2] For this reason the term "radio-active lead" although it describes the fact, is perhaps not from a theoretical point of view the best designation of either uranium or thorium lead; but the term is convenient because it distinguishes between these two forms and common lead.

[3] This is the Harvard result. If Hönigschmid's value is given equal weight, the average observed value would be 206.07, exactly identical with the hypothetical value.

attempt on record to compute an atomic weight from hypothetical assumptions. Usually we are wholly at a loss as to the theory underlying the precise relationships, and must determine our values by careful experiment alone.

The value 206.08 for the atomic weight of lead has further support in the fact that it is more nearly half way between thallium, 204, and bismuth, 208, the two neighboring elements in the periodic system, than is the atomic weight 207.2 possessed by ordinary lead.

It appears, then, that 206, the value pertaining to uranium-lead, is a very reasonable value.

But, as has been repeatedly pointed out, ordinary lead, constituting the vast bulk of the lead in the world, has without doubt a much higher atomic weight, 207.2, not to be expected from either of the lines of reasoning just given. In order to test the uniformity of this circumstance, Professor Baxter, of Harvard, with the help of one of his assistants, investigated ordinary lead from non-uraniferous ores from many parts of the world, and discovered that the constancy of its quantitative behavior is as striking as that of copper or silver. His figures agreed very closely, within the limit of error of experimentation, with those obtained as a part of the present comparison of the two kinds of lead, so that there could be no question as to lack of identity of methods or precautions.

Before leaving the subject of the relative atomic weights of these two types of lead, it is not without interest to note the exact absolute weights of the atoms. If, as we have excellent reason for believing on the basis of the brilliant work of Professor R. A. Millikan, a so-called gram-atom (the atomic weight in grams) contains 606.2 sextillion actual atoms, the weights of the atoms of the two kinds of lead must be respectively 342 and 340 septillionth of a gram. Their extreme smallness, as regards bulk, may perhaps best be inferred from the consideration that the smallest object visible as a point in the common microscope has a diameter probably about one thousand times as great as an atom of lead.[4]

Evidently, on the basis of the quantitative results just exhibited, we must admit that there is at least one real difference between radioactive lead and the common metal. Are there other differences?

A question as to the density of each substance, and therefore as to the bulk occupied by the respective atoms, at once arises. Since the atom of uranium-lead weighs less than the other, it must occupy less space, supposing that it has the same density; or else it must have less density, supposing that it should occupy the same space. The identity of the chemical behavior of the two types of lead suggests the probability of the latter alternative, and this was therefore assumed by Soddy; but experimental proof was evidently desirable. Therefore an extended investigation of the density of the various kinds of lead was carried out likewise in the Gibbs Memorial Laboratory. As a matter of fact, the densities of the several specimens were found to be very nearly proportional to their atomic weights; that is to say, the bulk of the atom of radioactive lead is almost exactly the same as the bulk of the atom of ordinary lead, although the weights of these atoms are so markedly different.

DENSITIES AND ATOMIC VOLUMES

	Automatic Weight	Density	Atomic Volume
Pure uranio-lead	206.08	11.273	18.281
Australian mixture	206.34	11.289	18.278
Pure common lead	207.19	11.337	18.277

A distinctive property of elementary substances, which has always been supposed to be concerned more or less definitely with the atomic weight, is the spectrum, depending upon the wave-lengths of light emitted by the vapor. But, surprisingly enough, the spectrum lines produced by these two sorts of lead, when heated to the high temperature of the electric arc, are so precisely alike, both as to

[4] If the smallest object visible in a microscope could be enlarged to the width of this printed page, the atoms in it would appear about the size of the dots on the letters i, or the periods, in the type above.

their wave-lengths and their intensities, that no ordinary spectrum analysis shows any difference whatever. This has been proved by careful experiments at Harvard and elsewhere, and is made obvious by the photographs now thrown on the screen. A and B were from two different specimens of radioactive lead, C from ordinary lead, all very carefully purified. The range covered is about from 3,000 to 2,000 wave-length—far in the ultra-violet. Very recently Professor W. D. Harkins, of Chicago, and two assistants, have detected, with a very extended grating spectrum, an exceedingly minute shift (0.0001 per cent. of the wave length—an amount far too small to be shown by the spectra exhibited) of one of the lines. The wonder is, not that there should be a difference, but rather that they should be so very nearly identical. Evidently the very considerable difference in the atomic weight produces only a barely perceptible effect on the wave-lengths of light emitted by the several isotopic forms of a given element, although a less difference in atomic weight between two different elements (for example, cobalt and nickel) is concomitant with utterly divergent spectra.

Another very interesting question, involving the relations of substance both to light and to weight (or rather density) is its refractive index. All the formulæ relating to molecular refraction involve the *density* of the substance concerned. In the case under consideration, do the differing weights of the atoms, and therefore the differing densities of the same compounds of the two kinds of lead, affect the refractive indices of the salts? It the refractive index of a given salt of radio lead identical with that of the same salt of ordinary lead? Evidence on this point would go far to decide whether density or atomic volume is the more important thing in determining refractive index. A very careful study carried out with the help of Dr. W. C. Schumb at Harvard has within the past few months shown that as a matter of fact the refractive index or ordinary lead nitrate is identical with that of the nitrate of radiolead within one part in nearly twenty thousand, a result which shows that density is a less important factor in deterining refractive index than had been previously assumed.

Both of these conclusions concerning light—that drawn from the spectra and that drawn form the refractive indices—have a yet more far reaching interest, for they give us a further clue as regards the innermost nature of the atom. That part of the atom which determines its weight seems to have, at least in these cases, very little effect on that part of the atom which determines its behavior toward light.

Immediately connected with the question of density of the solid salts is the question as to the densities of their saturated solutions, as well as to the extent of saturation. Fajans and Lembert had recently obtained results probably indicating that the molecular solubility of each kind of lead is the same, and that the densities of the solutions are different, the density of the radiolead solution being less to an extent consistent with its smaller molecular weight. These results, however, left much to be desired in the way of accuracy, and needed verification. Therefore a very careful investigation, begun at Harvard with the assistance of Schumb, before the appearance of Fajan's publication, furnished valuable knowledge on this point.

SOLUBILITY OF TWO KINDS OF LEAD NITRATE*

	Common Lead	Uranium Lead
Per cent. salt in saturated solution (25.00°)	37.342	37.280
Grams lead per 100 grams water	37.28	37.130
Molecular solubility per 1,000 grams water	1.7993	1.7989

Here, again, differences in weight alone are manifest, and these are proportional to the differences in the atomic weights; the molecular behavior is essentially identical in the two sorts.

The identity in solubility might also be inferred from the impossibility of separating the

* The uranium lead used in these determinations was a specimen from Australia having the atomic weight 206.41, not quite like the earlier sample, but not different in important degree.

two kinds of lead from each other by fractional crystallization. This was predicted by Soddy, and tested by him and by others. Various vain attempts have been made to separate the different kinds of lead from one another, but apparently when once they are mixed, no chemical method can separate them, since the properties of the different kinds are so nearly alike. The latest attempt at the Gibbs Memorial Laboratory involved one thousand fractional crystallizations of the Australian lead nitrate, which is believed to contain both ordinary and uranium-radium-lead. The extreme fraction of the crystals (representing the least soluble portion, if any difference in solubility might exist) gave within the limit of error the same atomic weight as the extreme fraction of the mother liquor (representing the most soluble portion), thus confirming the work of others in this direction.

When wires constructed of two different metals are joined, and the junction heated, an electrical potential or electromotive force is produced at the junction. This property seemed, then, to be a highly interesting one to test, in order to find out how great may be the similarity of the two kinds of lead. In fact, wires made of radioactive lead and ordinary lead tested in the Gibbs Laboratory gave no measurable thermoelectric effect, the wires acting as if they were made of the same identical substance, although the atomic weights and densities were different. No other known case of this sort is known, so far as I am aware. The melting points of the two kinds of lead were likewise found, with the assistance of N. F. Hall, to be identified within the probable accuracy of the experiment.

Let us bring all these results together into one table, so that we may better grasp their combined significance.

Summed up in a few words, the situation appears to be this: At least two kinds of lead exist: one, the ordinary metal disseminated throughout the world, in non-uraniferous ores; another, a form of lead apparently produced by the decomposition of uranium, radium being one of the intermediate products. If we leave out of consideration the probably inessential difference in radioactivity, the two kinds are very closely if not exactly alike in every respect, excepting atomic weight, density and immediately related properties involving weight, such as solubility. Thorium lead appears to be a third variety, with similar relations. Shall we call these substances different elements, or the same? The best answer is that proposed by Soddy who invented a new name, and called them "isotopes" of the same element.

COMPARISON OF PROPERTIES OF DIFFERENT KINDS OF LEAD[5]

	Common Lead	Mixture (Australian)	Uranio-Lead	Percentage Difference	
	A	B	C	A–B	A–C
Atomic weight	207.19	206.34	206.08	0.42	0.54
Density	11.337	11.289	11.273	0.42	0.56
Atomic volume	18.277	18.278	18.281	0.01	0.02
Melting point (absolute)	600.53	600.59	—	0.01	—
Solubility (metal as nitrate)	37.281	37.130	—	0.41	—
Refractive index of nitrate	1.7815	1.7814	—	0.01	—
Thermoelectric effect	—	—	—	0.00	—
Spectrum wave length	—	—	—	0.00	0.00

Since every new fact concerning the behavior of the elements gives a new possible means of discovering something about their nature, and since these facts are of especially significant kind, the anomaly is of more than passing interest, and may be said to constitute one of the most interesting and puzzling situations now presented to the chemist who looks for the deeper meanings of things.

Many new queries arise in one's mind from a study of the data. Among them is a question as to the nature of ordinary lead, which possesses a less reasonable atomic weight than the radioactive variety. Why should this state of things exist?

Ordinary lead may be either a pure substance, or else a mixture of uranium-lead with lead of yet higher atomic weight, perhaps 208. The latter substance might be formed, as

[5] For the sake of better comparison, all the results given are those obtained at Harvard. No results of experiments elsewhere are inconsistent with these.

Soddy points out, if thorium (over 232) lost six atoms of helium, and he and Hönigschmid have found quantitative evidence of its existence in thorium minerals.

After reviewing all the data, Professor F. W. Clarke has brought forward an interesting and reasonable hypothesis explaining the difference between the several kinds of lead. He points out that whereas we have every reason to believe that uranium and thorium lead are the results of disintegration of heavier atoms, ordinary lead may be imagined to be the product of a far earlier synthesis or evolution from smaller atoms. The hypothesis might be supported by the analogy of the synthesis and decomposition of organic substances, which by no means always follow similar paths; it seems to be consistent with most, if not all, of the facts now known.

On the other hand, may not the uniformity of ordinary lead and its difference from either of the radioactive leads be almost equally capable of interpretation in quite a different fashion? Whenever, in the inconceivably distant past, the element lead was evolved, it is hardly to be supposed that uranium-lead and thorium-lead could have been entirely absent. The conditions must have been chaotic and favorable to mixture. When the two or more forms were mixed, none of the processes of nature would separate them. Therefore they must appear eons afterwards in an equably mixed state on earth, constituting our ordinary lead. There may have been more than two forms of lead; but two forms, one possessing an atomic weight 206 and the other, an atomic weight over 208, would account for all the facts. The identity in nature of all the common lead on earth might indicate merely that one time all the matter now constituting the earth was liquid or gaseous in violent agitation, so that all the kinds of lead were thoroughly commingled before solidification. This explanation, if it could be confirmed, would furnish important evidence concerning the early history of planets. So far afield may a difference in weight amounting to two units in the twenty-fourth decimal place, between two kinds of atoms so small as to be far beyond the possible range of our most piercing means of actual observation, carry the inquiring investigator!

The true answers to these questions are not to be found by speculation, such as that just detailed, however suggestive such speculation may be. They are to be found by careful observation. For example, the doubt as to the nature of ordinary lead can only be decided by discovering whether or not it may be separated into two constituents. Since weight (or mass) is the quality distinguishing between the several isotopes or kinds of lead, weight (or mass) must be made the basis of separation. Hence the only hope of separating isotopes of lead lies in the method of fractional diffusion, as has been already suggested by many other experimenters on this subject. Promising preliminary experiments preparatory to such an undertaking have already been begun at Harvard, and before long more light may be obtained.

The idea that other elementary substances also may be mixtures of two or more isotopes has been advanced by several chemists. Especially if ordinary lead should really be found to be thus complicated, many, if not all, other elements should be tested in the same way. The outcome, while not in the least affecting our table of atomic weights as far as practical purposes are concerned, might lead to highly interesting theoretical conclusions.

How can such remote scientific knowledge, even if it satisfies our ever-insistent intellectual curiosity, be of any practical use? Who can tell? It must be admitted that the relationship is apparently slight as regards any immediate application, but one can never know how soon any new knowledge concerning the nature of things may bear unexpected fruit. Faraday had no conception of the electric locomotive or the power-plants of Niagara when he performed those crucial experiments with magnets and wires that laid the basis for the dynamo. Nearly fifty years elapsed before his experiments on electric induction in moving wires bore fruit in a practical electric lighting system; and yet more years before the trolley car, depending equally upon the principles discovered by Faraday, became an everyday occurrence. At the time of discovery, even

if the wide bearing and extraordinary usefulness of his experiments could have been foreseen by him, they were certainly hidden from the world at large.

The laws of nature can not be intelligently applied until they are understood, and in order to understand them, many experiments bearing upon the fundamental nature of things must be made, in order that all may be combined in a far-reaching generalization impossible without the detailed knowledge upon which it rests. When mankind discovers the fundamental laws underlying any set of phenomena,these phenomena come in much larger measure than before his control, and are applicable for his service. Until we understand the laws, all depends upon chance. Hence, merely from the practical point of view, concerning the material progress of humanity, the exact understanding of the laws of nature is one of the most important of all the problems presented to man; and the unknown laws underlying the nature of the elements are obviously among the most fundamental of these laws of nature.

Such gain in knowledge brings with it augmented responsibilities. Science gives human beings vastly increased power. This power has immeasurably beneficent possibilities, but it may be used for ill as well as for good. Science has recently been blamed by superficial critics, but she is not at fault if her great potentialities are sometimes perverted to serve malignant ends. Is not such atrocious perversion due rather to the fact that the ethical enlightenment of a part of the human race has not kept pace with the progress of science? May mankind be generous and high-minded enough to use the bountiful resources of nature, not for evil, but for good, in the days to come!

THEODORE W. RICHARDS
HARVARD UNIVERSITY

PROCEEDINGS OF THE BALTIMORE MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE seventy-first meeting of the American Association for the Advancement of Science was held at Baltimore from December 23 to 28, and in view of the unusual conditions it has been a decided success. It will be remembered that the meeting place was changed from Boston to Baltimore, partly because war conditions had brought together at Washington scientific men from all over the country, and it was planned to have a brief compact program devoted to war issues and topics more intimately pertinent to the immediate welfare of the country. While it was not feasible to have the meetings in Washington, it was thought that members in Washington might be able to attend meetings at Baltimore, but a short distance away.

With the sudden termination of hostilities the problems confronting the scientific workers have to a large extent either suddenly changed their nature altogether or have been considerably modified and, although but a short time has intervened since the signing of the armistice, the nature of the contributions and discussions in the various meetings shows a quick recognition and adjustment to these changed conditions.

The rapid release of men by demobilization and the prevalent less congested conditions as to university buildings and hotel accommodations have apparently been partly responsible for the surprisingly large enrollment. The opening meeting at McCoy Hall on the evening of December 26 had an attendance of about four hundred people, and the total registration for the week was seven hundred and twenty-eight, which did not include some of the members of the various affiliated societies. At the opening meeting Dr. Edward L. Nichols announced that the address of the retiring president of the association, Dr. Theodore W. Richards, on "The Problems of Radioactive Lead" would not be given, Dr. Richards being

unable to attend the meeting on account of illness. Dr. Nichols then introduced the president-elect, Dr. John M. Coulter, who in turn presented President Goodnow, of the Johns Hopkins University.

In his address of welcome Dr. Goodnow spoke as follows:

It is my privilege on behalf of the Johns Hopkins University to bid you welcome here to-night. It has been a great pleasure for us to feel that we have been able even in a small way to be of service to you on the occasion of this meeting.

It is always an honor for a university to cooperate with the association. But, at the present time, it is peculiarly gratifying to have the opportunity of testifying to the worth of the work which men of science have been and are now doing.

Science has within the past few years assumed perhaps a greater importance than it has ever before had, or, at any rate, the accomplishments of science have bulked larger in the public eye than heretofore. The struggle which has just closed has probably made greater demands on the scientific man than have ever hitherto been made. Science has, indeed, been forced to become the servant of Mars. The great war has called upon men of science to devise new weapons of both offense and defense. Without their efforts it would have been a very different conflict from what it has been.

The ruthlessness with which our knowledge of scientific law has recently been applied to the destruction of life and property has, I am afraid, however, caused not a few to entertain a certain amount of apprehension as to the effects upon human life of scientific training. If a greater scientific knowledge is to bring with it the will to use that knowledge as it has been used during the past four years, civilization, which has been the product of so many centuries of human endeavor, would seem to have a perilous future.

Such apprehensions are, however, I am sure, quite unfounded. Science, it is true, is in large measure unmoral. It has to do with natural law rather than with human relationships, and it is with human relationships that morality is concerned. Knowledge, of course, is power, and power or might is not necessarily right.

We are told, it is true, that man can not live by bread alone. But that is not to say that he does not live at all by bread. He must have bread and he must have science. We must, so long as we live, attempt to increase our knowledge. We must endeavor through science to acquire power, to conquer Nature, to learn from her how best we may live.

But that endeavor need not prevent us from at the same time striving to live well-ordered lives, to form a social organization in which right relationships shall be established, in which right rather than might shall be controlling. We may at the same time search for truth and labor for the adoption of ethical standards in accordance with which our knowledge of science may be applied.

I have said that in no period in the past has science assumed such importance as in the last four years. I may add that the rôle of science in the immediate future will be of even greater significance. In the period of reconstruction upon which we are now entering, science will be called upon to bind the wounds of a bleeding world sick almost unto death. It must in some way show us how to increase production in order that we may feed the starving, house those without shelter, and clothe the naked. Never before have the demands upon the scientific man been so insistent as they soon will be. And fortunately they will be demands which he can meet without any secret lurking thought that his success will be followed by sorrow and misery. He can rejoice in the belief that his efforts will bring comfort to many whose lot has been hopelessness if not despair.

For this reason I congratulate you men of science upon the opportunity which now presents itself. We are living in a very different world from that which existed only four years ago. Old traditions have been cast aside. New standards are in process of adoption. Great impetus has been given to the belief in the necessity of scientific research.

I wish you all success in this, your first meeting in the new era upon which we are just entering.

In behalf of the Association the response to President Goodnow's welcome was made by Dr. Coulter, as follows:

In behalf of the association, I wish to express our appreciation of the greeting extended by President Goodnow. Johns Hopkins University is a peculiarly fitting place for a meeting of the American Association, for historically it is our first research university, an example and a stimulus to the other universities of the country. Those

of us who are older can recall the distinguished names that brought to Johns Hopkins its prestige in research.

President Goodnow has characterized science as a power let loose for destruction during the late war, a giant that has discovered its strength. Everything depends upon how the power is applied, but I am sure that science prefers to apply its strength in public service rather than in destruction. The great war has been called a war of science, but I trust that this kind of service that science has been called upon to render is but a prelude to a recognition of the fact that the progress of a peaceful civilization is also based upon scientific research.

Speaking for this association, I am sure that we are ready to pledge ourselves to use our science in constructive work, for the advancement of knowledge and for the public welfare.

In accordance with the present constitution, notice was served by Dr. Edward L. Nichols that a revised constitution and by-laws will be presented next year to be voted upon, the principle changes being those of increase in the number of sections and a condensation in form of the present constitution.

Meeting in affiliation with the association were twenty-one other organizations, as follows, many of these affiliated societies having certain sessions in conjunction with corresponding sections of the association:

American Federation of Teachers of the Mathematical and Natural Sciences,
American Physical Society,
Optical Society of America,
Society for Promotion of Engineering Education,
Geological Society of America,
Association of American Geographers,
Paleontological Society of America,
American Society of Naturalists,
American Society of Zoologists,
American Association of Economic Entomologists,
Botanical Society of America,
American Phytopathological Society,
Ecological Society of America,
American Anthropological Association,
American Psychological Association,
American Folk-Lore Society,
American Metric Association,
Society of American Bacteriologists,
American Society for Horticultural Science,
Society of American Foresters,
School Garden Association of America.

Two of the affiliated societies met on Monday and Tuesday in advance of the opening meetings of the association: The School Garden Association of America and the American Phytopathological Society, the sessions of the latter organization continuing till Saturday.

The various meetings were held in Gilman, Hall, the Civil Engineering Building, and the Mechanical and Electrical Engineering Building, at the splendid new site of Johns Hopkins University at Homewood, towards the northern part of Baltimore, and the accommodations for the meetings of the various societies and sections were found to be convenient and amply sufficient. Inexpensive and ample lunches were provided in the Mechanical and Electrical Engineering Building.

There were held perhaps the usual numbers of dinners and smokers, at which addresses of retiring presidents, invitation papers, or other interesting features were presented. The Phytopathological Society had a dinner on Wednesday evening and the Ecologists an informal dinner on Thursday evening, while after the opening session of the association, the biologists gathered for an informal smoker. On Friday evening, dinners were held by the botanists, the American Metric Association, the American Society for Horticultural Science, while the Society of American Foresters had a smoker and "Round Table Talks." On Saturday night the American Society of Naturalists held a dinner, at the close of which Vernon L. Kellogg was to have spoken on "The German Philosophy of the War" but was detained in France. The annual dinner of

the Geological Society was held at the same time elsewhere. The Association of University Professors met on Saturday at the Hopkins Club.

In the Botanical Laboratories in Gilman Hall there was displayed an exhibit showing the use of sphagnum moss in the preparation of surgical dressings, as prepared by Dr. Geo. E. Nichols, Botanical Adviser on Sphagnum for the American Red Cross.

Some of the most noticeable features of the Baltimore meeting were the tendency towards cooperation and team-work among investigators, attacking problems jointly under well-developed plans, and the considerable number of notable addresses, often given by men of large responsibilities in governmental or war work and relating the problems of reconstruction. The experiences of the past two years have had an important bearing on methods of research and an important address was that given by Dr. George E. Hale, entitled "The National Research Council," in which the future organization and functioning of that institution were discussed. Altogether it is probably safe to state that about four hundred addresses and shorter papers were presented at the various meetings.

The addresses of the retiring vice-presidents were as follows:

Section A.—Henry Norris Russell, on "Some problems of sidereal astronomy."

Section B.—W. J. Humphreys, on "Some recent contributions to the physics of the air."

Section C.—William A. Noyes, on "Valence."

Section D.—Henry Sturgis Drinker, on "The need of conservation of our vital and natural resources as emphasized by the lessons of the war."

Section E.—George Henry Perkins, on "Vermont physiography."

Section F.—Herbert Osborn, on "Zoological aims and values."

Section G.—Burton E. Livingston, on "Some responsibilities of botanical science."

Section H.—E. L. Thorndike, on "Scientific personnel work in the army."

Section L.—Edward F. Buchner, on "Scientific contributions of the educational survey."

Section M.—Henry J. Waters, on "The farmer's gain from the war."

As honorary associates of the Baltimore meeting the council elected Dr. Professor Fabio Frassetto, of the University of Bologna and now of the Royal Italian Embassy at Washington, and Dr. Georgio Abetti, vice-secretary of the Italian Society for the Advancement of Science, both of these men being in attendance at the meetings.

The next meeting of the association will be held in St. Louis, beginning the first Monday after Christmas, 1919. The results of elections of officers for the ensuing year were as follows:

President: Simon Flexner, director of the Rockefeller Institute for Medical Research, New York City.

Vice-Presidents:

Section B.—Theodore Lyman, Harvard University, Cambridge, Mass.

Section C.—B. F. Lovelace, The Johns Hopkins University, Baltimore, Md.

Section E.—C. K. Leith, University of Wisconsin, Madison, Wis.

Section F.—Wm. M. Wheeler, Bussey Institution, Boston, Mass.

Section G.—L. H. Pammel, Iowa State College, Ames, Iowa.

Section H.—R. M. Yerkes, University of Minnesota, Minneapolis, Minn.

Section L.—V. A. C. Henmon, University of Wisconsin, Madison, Wis.

Section M.—A. F. Woods, Maryland Agricultural College, College Park, Md.

Secretary of the Council: J. F. Abbott, Washington University, St. Louis, Mo.

General Secretary: Geo. T. Moore, Missouri Botanic Garden, St. Louis, Mo.

Nine men were elected members of the committee on grants, as follows: N. L. Britton, Louis I. Dublin and J. McK. Cattell for one year; G. N. Lewis, W. B. Cannon, and R. T. Chamberlin for two years; and Henry Crew, Joel Stebbins, and G. H. Parker for three years.

To fill vacancies in the council of the association Drs. N. L. Britton and J. McK. Cattell were reelected and Dr. J. C. Merriam was elected as a new member. Dr. E. F. Buchner was appointed to represent the association in the American Council of Education, and J. C. Merriam, H. B. Ward, and Stewart Paton were elected to serve for three years on the Committee on Policy.

The report for 1918 of the treasurer of the association, Dr. Robert S. Woodward, showed total cash receipts of $7,747.27 and disbursements $7,786.00, including the purchase of $4,000 Liberty Bonds. The total funds of the association are now $116,605.45.

The financial report of the permanent secretary, L. O. Howard, for the period November 1, 1917, to October 30, 1918, showed receipts $43,784.49 and expenditures of $36,209.04, leaving a balance of $7,575.45.

The two financial reports will be printed in full in a later issue of SCIENCE.

O. E. JENNINGS,
General Secretary.

SCIENTIFIC EVENTS

THE KATMAI NATIONAL MONUMENT

PRESIDENT WILSON has created by proclamation the Katmai National Monument. This reservation incloses what the explosive eruption of June, 1912, left of Mount Katmai, on the southern shore of Alaska, together with several neighboring valleys of steaming vents, the largest of which the National Geographic Society, which explored it in June, 1917, named the "Valley of Ten Thousand Smokes."

The two features are intimately related. Rock strata superheated since the great eruption underlie Katmai near enough to the surface to turn to instant steam the spring and drainage waters of many a surrounding mile of foothills. Thus originates the steam which bursts from the myriad valley vents. The phenomenon is familiar in the neighborhood of most volcanoes which still are classed as active. Steaming springs, a later stage of the vents in this valley, are found upon the flanks of several of the most prominent of our Cascade volcanoes, and are numerous around the base of Lassen Peak.

The comparison, however, between Katmai's steaming valleys and the geyser basins of Yellowstone is especially instructive because Yellowstone's basins once were what Katmai's steaming valleys are now. The "Valley of Ten Thousand Smokes" is probably a coming geyser field of enormous size. The explanation is simple. Bunsen's geyser theory, now generally accepted, presupposes a column of water filling the geyser vent above a deep rocky superheated chamber in which trickling spring water is being rapidly turned into steam. When this steam becomes plentiful enough and sufficiently compressed to overcome the weight of the water in the vent, it suddenly expands and hurls the water out. That is what makes the geyser play.

Now, the difference between the Yellowstone geyser fields and Katmai's steaming valleys is just a difference in temperature. The entire depth of earth under these valleys is heated far above boiling point, so that it is not possible for water to remain in the vents; it turns to steam as fast as it collects and rushes out at the top in continuous flow. But when centuries or hundreds of centuries enough elapse for the rocks between the surface and the deep internal pockets to cool, the water will remain in many vents as water until, at regular intervals, enough steam gathers below to hurl it out. Then these valleys will become

basins of geysers and hot springs like Yellowstone's.

The crater of Katmai is very large. Its circumference, says Robert F. Griggs, who headed the expeditions which explored the entire area, is 8.4 miles, measured along the highest point of the rim.

The area is 4.6 miles. The precipitous abyss, which does not extend to the rim of the southwest side, is somewhat shorter, measuring 2.6 miles in length, 7.6 miles in circumference, and 4.2 square miles in area. The milky blue lake at the bottom is 1.4 miles long and nine tenths of a mile wide, with an area of 1.1 square miles. The little cresent-shaped island in the lake measures 400 feet from point to point. The precipice from the lake to the highest point of the rim is 3,700 feet.

Mr. Griggs estimates the capacity of the hole at 4,500,000,000 cubic yards. If this hole were filled with water, there would be enough to supply New York City for 1,635 days. The great eruption blew out 11,000,000,000 cubic yards of material, more than forty times the amount removed in the construction of the Panama Canal.

AGRICULTURAL PRODUCTION IN THE UNITED STATES

How American farmers responded to the food needs of the United States and the countries with which it was associated in the war is described in detail in the annual report of the Secretary of Agriculture, David F. Houston, just made public.

For wheat and other leading cereals and for potatoes, tobacco and cotton, farmers in 1918 planted 289,000,000 acres, an increase over the preceding record year of 5,600,000. It is especially noteworthy, the secretary points out that, while the acreage planted in wheat in 1917 was slightly less than for the record year of 1915, it exceeded the five-year average (1910–14) by 7,000,000; that the acreage planted in 1918 exceeded the previous record by 3,500,000; and that the indications are that the acreage planted during the current fall season will considerably exceed that of any preceding fall planting.

Notwithstanding adverse climatic conditions in 1917, especially for wheat, and in 1918 especially for corn, the secretary reports that only 1915 has exceeded either 1917 or 1918 in the aggregate yield of wheat and other leading cereals.

"The estimated total for 1917," he explains, "was 5,796,000,000 bushels and for 1918, 5,638,000,000 bushels, a decrease of approximately 160,000,000 bushels. But the conclusion would be unwarranted that the available supplies for human food or the aggregate nutritive value will be less in 1918 than in 1917. Fortunately, the wheat production for the current year—918,920,000 bushels—is greatly in excess of that for each of the preceding two years, 650,828,000 in 1917, and 636,318,000 in 1916, and is next to the record wheat crop of the nation. The estimated corn crop, 2,749,000,000 bushels, exceeds the five-year pre-war average by 17,000,000 bushels, is 3.4 per cent. above the average in quality and greatly superior to that of 1917."

Turning to live stock, the secretary notes that the number of pounds of beef for 1918 is given at 8,500,000,000 pounds, as against 6,079,000,000 for 1914, the year preceding the European war; and that the total for 1918 of beef pork and mutton is given at 19,495,000,000 pounds, as against 15,587,000,000 pounds for 1914.

On the basis of prices that have recently prevailed, the secretary says, the value of all crops produced in 1918 and of live stock on farms on January 1, including horses, mules, cattle, sheep, swine and poultry, is estimated to be $24,700,000,000, compared with $21,325,000,000 for 1917 and $11,700,000,000, the annual average in the five-year period 1910 to 1914. This greatly increased financial showing, the secretary explains, does not mean that the nation is better off to that extent, or that its real wealth has advanced in that proportion. Considering merely the domestic relations, the true state is indicated rather in terms of real commodities. The increased values, however, do reveal that monetary returns to the farmers have increased proportionately with those of other groups of producers in the nation and that their purchasing power has kept pace in the rising scale of prices.

Yields in 1918 of the major food crops were as follows, according to unrevised estimates: 2,749,198,000 bushels of corn; 918,920,000 bushels of wheat; 1,535,297,000 bushels of oats; 236,505,000 bushels of barley; 76,687,000 bushels of rye; 18,370,000 bushels of buckwheat; 41,918,000 bushels of rice; 61,182,000 bushels of kafirs; 390,101,000 bushels of Irish potatoes; 88,114,000 bushels of sweet potatoes; 17,802,000 bushels of commercial beans; 40,185,000 bushels of peaches; 10,342,000 bushels of pears; 197,360,000 bushels of apples; 6,549,000 tons of sugar beets; 29,757,000 gallons of sorghum sirup; 52,617,000 bushels of peanuts.

The estimated 1918 production of all the cereals, 5,638,077,000 bushels, compares with 5,796,332,000 bushels in 1917, and 4,883,819,000 bushels, the annual average in the five-year period 1910–14. On January 1, 1918, it is estimated there were on American farms 21,563,000 horses, compared with an average of 20,430,000 in the five years 1910–14; 4,824,000 mules, compared with 4,346,000; 23,284,000 milch cows, compared with 20,676,000; 43,546,000 other cattle, compared with 38,000,000; 48,900,000 sheep (an increase, for the first time in many years, over the preceding year), compared with 51,929,000; 71,374,000 swine, compared with 61,865,000.

The estimated 1918 production of beef, 8,500,000,000 pounds, compares with 7,384,007,000 pounds in 1917; 10,500,000,000 pounds of pork compared with 8,450,148,000; 495,000,000 pounds of mutton and goat meat compared with 491,205,000; 8,429,000,000 gallons of milk produced in 1918 was 141,000,000 pounds more than the 1917 production; 299,921,000 pounds of wool, 18,029,000 pounds more than 1917; 1,921,000,000 dozens of eggs, 37,000,000 dozens more; 589,000,000 head of poultry, 11,000,000 more.

THE EDWARD K. WARREN FOUNDATION AND TWO WILD LIFE RESERVATIONS IN MICHIGAN

IT will be of interest to zoologists and botanists, particularly ecologists and those interested in the fauna and flora of the Middle West, to learn what two areas in southwestern Michigan have been set aside as wild life preserves. The tracts comprise 300 acres (150 or more of the original forest) situated two and a half miles north of Three Oaks, in Chickaming Township, Berrien County, and over 250 acres in the sand dune region on the shore of Lake Michigan, in Lake Township, two miles north of Sawyer, in Berrien County.

The forest is a remnant of the original beech-maple forest of southern Michigan. It has never been cut or burned over and many of the trees are splendid specimens, fifty to seventy feet in height to the first limb, and from two to four feet in circumference. The Galien River flows through the forest for about one and one half miles and there are numerous springs.

The sand dune tract has a frontage on Lake Michigan of about 3,000 feet. It includes probably the highest dunes in the State of Michigan, the largest of which are from two hundred to three hundred feet in height. Much of the tract is wild and with little doubt the original vegetation prevails in most places.

The preserves have been established by Mr. and Mrs. Edward K. Warren, of Three Oaks, Michigan, and are incorporated in the "Edward K. Warren Foundation," which also includes the Chamberlain Memorial Museum at Three Oaks, founded in 1915 and opened to the public in 1916.

The forest has been in Mr. Warren's possession for forty years, and has been preserved by him for its great natural beauty, and both tracts have been set aside that future generations may have an example of the primitive floral and fauna conditions in southern Michigan, that nature lovers may find here many of the animals and plants which are being exterminated elsewhere, and that students of biology may have available a place where they can study native animals and plants in their natural habitats. Some of the sand dune area has been more recently acquired, and it is typical of the good judgment and foresight of Mr. Warren that this area includes the best developed dunes and is the least disturbed tract in the sand dune region.

The Museum of Zoology of the University of

Michigan has been asked to make a detailed survey of the reservations, and it is planned to extend this survey over an indefinite number of years. Field laboratories will be provided by the foundation, and the museum will send specialists on the groups represented in the preserves to these laboratories at different times. The object of the field work will be to obtain a complete inventory of the plants and animals and to secure data upon the causes of fluctuations in numbers of individuals, that the fauna and flora may be maintained as nearly as possible in the primitive condition. At the same time it is expected that ecological data and information on the original biota will be obtained which will be of scientific interest. The specimens will be deposited in the Museum of Zoology and the Chamberlain Memorial Museum, and the published results of the work will appear from the Museum of Zoology under a common title.

Future generations will not fail to appreciate the good judgment and public spirit which have led to the recognition of the desirability of insuring the perpetuity of the wild life of these areas and the establishment of the preserves.

Alexander G. Ruthven
Museum of Zoology,
University of Michigan

THE ORGANIZATION OF YALE UNIVERSITY AND THE SHEFFIELD SCIENTIFIC SCHOOL

Meeting in extraordinary session on December 16, with but one member absent, the Yale Corporation reviewed the whole subject of university reconstruction, and voted fundamental changes which, when carried through, will radically alter the university organization. The important votes are as follows:

1. Voted, That the recommendation of the governing board of the Sheffield Scientific School that the undergraduate course "be lengthened from three to four years" be approved.

2. That in the opinion of the corporation the reasons which led to the establishment and maintenance of a course of "Selected studies in language, literature, history and the natural and social sciences" under the administration of the faculty of the Sheffield Scientific School are no longer valid.

3. That the governing board of the Sheffield Scientific School be requested to appoint a committee, of which the director shall be chairman, to prepare plans for the immediate establishment of a four-year undergraduate course and the discontinuance of the "select" course; reporting at the same time to the corporation whether, in the opinion of this committee, it is desirable to establish a scientific course in preparation for business.

4. That this committee be directed to confer with a similar committee to be appointed by the permanent officers of Yale College regarding the inter-departmental problems created by the proposed changes, in order that properly qualified students in either school may be given access to the courses of instruction offered by the other.

5. That the president be directed to call meetings of the two committees thus created, together with the chairman of the entrance examination committee, to devise means for carrying more fully into effect the policy of joint administration of entrance requirements for the two schools; with authority to recommend, for the consideration of the respective governing boards and the approval of the corporation, such changes as shall appear to them desirable in the scope of the entrance requirements themselves, and in the organization of the freshman year.

6. That in the opinion of the corporation it is practicable, as recommended by the executive board of the graduate school, to place the administration of all advanced degrees and certificates in science, comprising at present the degree of master of science, the certificate in public health, and the higher engineering degrees, under the jurisdiction of the graduate school, without interfering with the development of the departments of study concerned or their proper articulation with the undergraduate courses which lead up to them; and that under these circumstances the administration of the courses leading to these degrees should be transferred to the graduate school at the close of the present academic year.

7. That the executive board of the graduate school be requested to prepare for the consideration of the faculty and the approval of the corporation plans by which provision can be made for the necessary independence and the proper coordination of graduate and undergraduate work in other departments of study as well as in those immediately affected by this change; and to submit such plans to the governing boards of the two undergraduate schools for their information and for any suggestions which they may choose to make in connection therewith.

8. That in adopting the above resolutions the corporation does not thereby commit itself to maintaining as a permanent policy the present division between the college and the Sheffield Scientific School in freshman year.

SCIENTIFIC NOTES AND NEWS

DR. SIMON FLEXNER, director of the laboratories of the Rockefeller Institute for Medical Research, was elected president of the American Association for the Advancement of Science at the meeting held last week in Baltimore. Chairmen of the sections elected are given in the report of the general secretary, published elsewhere in the present issue of SCIENCE.

COLONEL E. D. SCOTT was elected president of the American Psychological Association at the meeting held last week in Baltimore.

AT the meeting of the American Association of University Professors, held in Baltimore during convocation week, Dr. Arthur O. Lovejoy, professor of philosophy in the Johns Hopkins University, was elected president.

DR. GEORGE L. STREETER has been appointed director of the department of embryology of the Carnegie Institution of Washington.

PROFESSOR A. E. KENNELLY, of Harvard University and the Massachusetts Institute of Technology, was elected an honorary member of the Institute of Electrical Engineers, London, November 22, 1918.

LIEUTENANT COLONEL HARVEY CUSHING, professor of surgery at Harvard University, was made last June neurological consultant to the American Expeditionary Forces, with headquarters at Neufchâteau.

DR. WILLIAM T. SHOEMAKER, of Philadelphia, in recognition of his services as ophthalmologist of Base Hospital Unit No. 10, from the Pennsylvania Hospital, which he accompanied to France in May, 1917, has been appointed ophthalmologist to all American hospitals in England, and recently left France to enter upon his new duties. The new appointment carries with it the rank of lieutenant colonel, and he has been recommended for the promotion.

DR. A. D. HIRSCHFELDER, of the University of Minnesota, is now with the research division of the Chemical Warfare Section and has been stationed in Baltimore.

DR. RAYMOND PEARL, chief of the statistical division of the United States Food Administration, has returned to this country from a two months trip in Europe on Food Administration business.

DR. A. G. ELLIS, associate professor of pathology at Jefferson Medical College, will proceed to Siam to organize the department of pathology in the Royal Medical College at Bangkok. The exact date of his departure has not been determined, and is contingent upon the return of Dr. W. M. L. Coplin, professor of pathology, who is with the American Expeditionary Forces in France, having charge of the organization of the hospital laboratories.

THE faculty of the medical school of Northwestern University, Evanston, Illinois, gave a dinner at the Hotel La Salle, Chicago, on December 12, in honor of Professor Emilius C. Dudley, who is retiring from the chair of gynecology after thirty-seven years of work. Many colleagues and friends of Dr. Dudley were there and several speakers both from the faculty and trustees bore witness to his great contribution to the development of modern medicine and the affectionate regard in which he was held.

At a meeting of the fellows of the Royal Society of Medicine, held on November 13, the diploma of honorary fellowship of the society was presented to Sir Alfred Keogh, G.C.B., late director-general of the British Army Medical Services.

Lieutenant Colonel Richard H. Harte, head of Base Hospital Unit No. 10, one of the first American Hospital units to arrive in France, is in the Pennsylvania Hospital recovering from a serious operation.

Mr. Charles D. Test, formerly chemist for the Western Potash Works of Antioch, Nebraska, has accepted a position on the staff of the United States Tariff Commission.

Due to the retirement of Mr. Wallace G. Levison, Edgar T. Wherry, of the Bureau of Chemistry at Washington, has been appointed editor-in-chief of *The American Mineralogist*, with the following associate editors: George F. Kunz, president, New York Mineralogical Club; Herbert P. Whitlock, American Museum of Natural History; Alexander H. Phillips, Princeton University; Waldemar T. Schaller, U. S. Geological Survey; Edward H. Kraus, University of Michigan; Austin F. Rogers, Leland Stanford Junior University; Thomas L. Walker, University of Toronto, Canada; and Samuel G. Gordon, Academy of Natural Sciences, Philadelphia.

At a joint meeting of the Franklin Institute and the Philadelphia Section of the American Chemical Society on December 5, Provost Smith delivered a lecture on "Chemistry in Old Philadelphia." In this lecture the work of twelve pioneers in chemistry was considered.

Professor Maurice A. Bigelow, director of the school of practical arts of Columbia University, recently delivered an address at the Brooklyn Botanic Garden on "Childrens' gardens in the coming reconstruction period."

The second lecture of the series of the Harvey Society will be by Colonel Eugene R. Whitemore on "Infectious diseases in the army." The lecture will be given at the New York Academy of Medicine on Saturday evening, January 11, at 8:30.

The Lady Priestley Memorial Lecture of the National Health Society at the Imperial College of Science and Technology, South Kensington, was given by Professor Bone, F.R.S., who took as his subject "Coal and health."

It is the desire of the American Committee of the Ramsay Memorial Fund to make the fund an expression of the esteem for Sir William Ramsay in this country. Many have expressed a wish to contribute, but have held back on account of their inability to send in a sum commensurate with their esteem. This has been due to the numerous calls made upon all for the past two years. Small sums, from one to five dollars, will be welcomed by the committee, which is anxious to make the expression of appreciation as widespread as possible. Contributions may be sent to Professor Charles Baskerville, chairman, College of the City of New York, or Mr. W. J. Matheson, treasurer, 21 Burling Slip, New York City.

According to a news despatch from France, the names of Lafayette and Wilbur Wright were joined, on December 22, by former Premier Painlevé, who spoke at the ceremonies incident to the laying of the foundation stone of the Wilbur Wright monument at Lemans, France. This was because Lafayette was a deputy of the Department of Sarthe, of which Lemans is the chief town, from 1812 to 1822, and three eminent French aviators, Fonck, Hurteau and Nungesser, were natives of this department. After sketching the lives of the Wright brothers, M. Painlevé said: "Let us honor Wilbur Wright's memory, first, as a good worker for human progress; second, because he brought to France the aid of his genius. Let his memory be joined with those of his young fellow citizens, who spontaneously brought their heroism to our aviation service."

Charles E. Phelps, engineer of the Maryland State Board of Health, formerly chief engineer of the Maryland Public Service Commision, died of pneumonia on December 22, aged forty-seven years.

JOHN P. CAMPBELL, for thirty years professor of biology in the University of Georgia, died on December 3. A correspondent writes that he was eminently a successful teacher and will be remembered by a large number of students whom he inspired. Le Conte Hall, erected in 1906 on the University of Georgia campus, is said to have been the first building in the south dedicated from the start to biological work.

WE learn from the *Journal* of the American Medical Association that the July-August number of the handsome journal issued by the national public health authorities of Cuba is entitled "Numero extraordinario en homenaje a la memorial de Dr. Carlos J. Finlay," on the anniversary of his death. It contains 197 pages with a photograph of Dr. Finlay and of the monument with his portrait bust which has been installed in the court of the headquarters of the public health department, the *Secretaria de Sanidad y Beneficencia*. All Finlay's scientific works are reproduced or summarized, from 1865 to 1912. His communication on the transmission of yellow fever through an intermediary agent was presented to the International Sanitary Conference at Washington, D. C., in 1881. He did not specify the mosquito in that communication, but did this in his address before the Academia de Ciencias Medicas, Fisicas y Naturales, at Havana, August 14, 1881. His address was republished in English and Spanish with the title "The mosquito hypothetically considered as an agent of transmission of yellow fever."

THE annual general meeting of the American Philosophical Society will be held from April 24 to 26, beginning at 2 P.M. on Thursday, April 24.

JOHN A. ROEBLING, of Bernardsville, New Jersey, has offered the British Museum a gift of five $1,000 bonds of the United States Liberty Loan, which is unaccompanied by conditions of any kind and is intended as a mark of community of sympathy which unites England and America. The trustees have accepted the gift and will consider to what purpose it may be most appropriately applied.

THE trustees of the British Museum are considering the question of reopening those parts of the museum which have been closed during the war, and of bringing out the treasures which have been stored in the basement. This may take some time, however, as one wing of the building is being used as the offices of a government department, and many of the exhibits are heavily sandbagged, and labor for uncovering them is not yet available.

WE learn from *Nature* that the British Scientific Instrument Research Association, one of the earliest associations formed under the scheme of the Department of Scientific and Industrial Research, has secured premises at 26 Russell Square, W.C., 1, where offices and research laboratories will be equipped. The first chairman of the association was Mr. A. S. Esslemont, whose recent lamented death has been a severe loss to the association. The council has elected Mr. H. A. Colefax, K.C., as chairman to fill the vacancy. The vice-chairman is Mr. Conrad Beck, to whose energy and personal influence is largely due the successful formation of the association. Almost all the leading optical and scientific instrument manufacturers are members. The department of scientific and industrial research is represented by Major C. J. Stewart, Captain F. O. Creagh-Osborne, R. N., Mr. S. W. Morrison, Colonel R. E. Home, R. A., and Mr. Percy Ashley. The council has recently co-opted as members of its body the Hon. Sir Charles A. Parsons, F.R.S., and Professor J. W. Nicholson, F.R.S. Sir Herbert Jackson, K. B. E., F.R.S., has been appointed director of research and Mr. J. W. Williamson secretary of the association.

WE learn from the London *Times* that the Salters' Company have issued a circular giving the outline of the Salters' Institute, now being founded to promote research in industrial chemistry, and to train students. An important part of the scheme is the foundation of Post-Graduate Fellowships. The new organization will be called "The Salters Institute of Industrial Chemistry," and for the

present will be located at the Salters' Hall, St. Swithin's-lane, E.C. This first business will be the appointment of a director, who must possess an exceptional knowledge of scientific and industrial chemistry. Among other things, the director will make arrangements between manufacturers and students and universities for the investigation of any particular problems requiring research, and give practical advice and information to those who are, or intend to become, industrial chemists, and especially to men whose careers have been interrupted or affected by naval, military, or national service. The Salters' Company will establish two types of fellowships for which post-graduate students of any recognized university will be eligible. The two classes are (*a*) fellowships to enable post-graduate students to continue their studies at an approved university or other institution under the general supervision of the director, (*b*) industrial fellowships to enable suitably equipped chemists to carry on research for any particular manufacturer, under an agreement which will be entered into between the institute, the manufacturer, and the fellow. Grants in aid may also be made to a certain number of persons who desire to improve themselves in the knowledge of their particular work by attending technical establishments or evening classes, at which they can obtain a better grasp of their subject.

At the session of the American Medical Association last June, a petition signed by a large number of the leading neurologists and psychiatrists of the United States and Canada was presented to the board of trustees, asking that the association publish a journal to be devoted to nervous and mental diseases, on a plan similar to that on which the *Archives of Internal Medicine* and the *American Journal of Diseases of Children* are published. The board held the matter under advisement until its October meeting, at which time it acted favorably on the petition, and authorized the publication of such a journal. The journal will be known as the *Archives of Neurology and Psychiatry*. The following were appointed as the editorial board: Dr. Pearce Bailey, New York, adjunct professor and assistant professor of neurology at Columbia University College of Physicians and Surgeons, New York Dr. Augustus Hoch, now of Montecito, Calif., formerly professor of clinical medicine, department of psycho-pathology at Cornell University Medical College; Dr. Hugh T. Patrick, Chicago, clinical professor of nervous and mental diseases, Northwestern University Medical School; Dr. E. E. Southard, Boston, professor of neurology, Medical School of Harvard University; Dr. Frederick Tilney, professor of neurology, Columbia University College of Physicians and Surgeons, New York Dr. T. H. Weisenburg, Philadelphia, professor of neuro-pathology and clinical neurology, University of Pennsylvania School of Medicine.

UNIVERSITY AND EDUCATIONAL NEWS

A gift of $100,000 to the University of Chicago for the erection of a building, preferably an administration building, was announced at the One Hundred and Ninth Convocation, the donor being Andrew MacLeish, vice-president of the university board of trustees. This is but one of a long list of benefactions for which the university is indebted to Mr. MacLeish.

Since building restrictions have been removed by the government, the erection of a number of new buildings, long in contemplation for the University of Tennessee, probably will be begun shortly.

One of the engineering buildings at the Pennsylvania State College was recently destroyed by fire, affecting the departments of industrial and mechanical engineering. A new building was just being completed and a second one has been begun. Temporary provision has been made for a forge shop and the steam engineering laboratory. Plans for other permanent buildings are being considered.

An International Committee for the Restoration of the University of Louvain has

been formed. National committees are being formed in the twenty-four nations which have adhered to the plan.

DR. EDWARD MARTIN, major in the Medical Reserve Corps and stationed at a camp in Georgia, has been elected emeritus professor of surgical physiology at the University of Pennsylvania.

DISCUSSION AND CORRESPONDENCE

LANTERN SLIDES OF NORTHERN FRANCE

IN response to a request from the National War Work Council, Y. M. C. A., for a set of lantern slides to illustrate their cantonment lectures on northern France, I began last June to search for photographs in various official and commercial collections by which the French views in the Gardner photograph collection of Harvard University might be supplemented. The search soon proving unsuccessful, a list of desired views was sent to Professor Lucien Gallois of the University of Paris, in the hope that he might be able to supply them: but he was just then called out with others to aid refugees who had been driven from their homes by the German advance to Château-Thierry on the Marne; and not until October was a shipment of 69 negatives received from him, representing the best selection that he could make under conditions as then limited. Since then a further delay in announcing the series has been occasioned by waiting for some admirable photographs taken during his service in France and lately brought home by Major Douglas W. Johnson.

The series of slides thus formed contains views of unequal value, some being reproduced from half-tone prints; but it represents the best collection I have been able to bring together. The happy coming of the armistice and the resulting dismemberment of the S. A. T. C.'s make the present announcement of the series rather out of season; but as the geography of northern France is likely to be a subject of general collegiate interest for some time to come the slides may be taken as "better late than never." The negatives have been placed in the hands of Mr. B. S. Turpin, 491 Boylston St., Boston, Mass., from whom a list of the slides with statement of cost may be obtained. All correspondence should be addressed to Mr. Turpin.

Good photographs of the following districts are much desired for the improvement of the series: General view of uplands adjoining the valley of the Somme, east of Amiens; uplands near Paris; general view of Laon, showing city on hill surmounting plain; general view of Rheims; escarpment of the first upland belt, southwest of Rheims; valley of the Meuse at Verdun; general view of Nancy; valley of the Orne in west slope of the fifth upland belt; escarpment at the notch of Saverne, looking north; general views in Lorraine east of Metz and of Nancy; view of the Vosges, looking west from the plain of Alsace; view of the plain of Alsace, from the foothills of the Vosges.

W. M. DAVIS

CAMBRIDGE, MASS.

BIOLOGICAL LITERATURE IN ENGLISH

THE German people have seen to it that the scientific literature of the world has been printed in German, that their people may have access to it. Other peoples have not done this, and the result is that the scientific world has been forced to know German. It has become the habit of most of our English and American scientists, as well as those in other countries, to publish their discoveries first in German and then (if they get to it) to publish in their own language.

A few years ago, when desiring an English translation of Fruwirth's "Die Büchtung der landwirtschaftlichen Kulturpflanzen," a four-volume work on the breeding of field crops, the present writer located translators, took up the matter with the publisher, Paul Parey of Berlin, and looked for an English publisher. The American publishing houses agreed that the data should be in English, but considered that they would not sell enough copies to pay for the undertaking.

Is it not about time that the English-speaking people see to it that the scientific literature

be published in English? Germany has furnished public funds when the publisher of technical data was not able to sell enough copies to make a profit. Can't the English people do as well?

The population of Germany was less than 67,000,000 before the war, and suppose that we consider the German-speaking people to be 100,000,000, we find that the United States of America alone has over 100,000,000 people. If we add to this the British Empire with about 438,000,000 we find it likely that about five times as many people speak English as speak German. There is more reason to have the world's scientific literature in English than to have it in German.

We, as biologists, do not realize how completely Germany had our scientific confidence until we pick up a work like the "International Catalogue of Scientific Literature," published in London. Turning to section L of this index, which is general biology, we find that of the 286 journals being quoted from before the war, 169 were German, 49 English, 25 Russian, 14 French, 10 Dutch, 8 Danish, 6 Hungarian, 3 Polish and 2 Swedish. In the German list have been placed the 20 Austrian journals, which are essentially German, 5 printed in Switzerland and 2 in Poland. Of the 49 English journals, 36 are printed in the United States. The French journals are scattered. Three are printed in Switzerland, two in Russia and one in Poland.

Frank A. Spragg

East Lansing, Mich.

A FLOWING ARTESIAN WELL AT WINSLOW, MAINE

Winslow, Maine, is situated on the east bank of the Kennebec River about 83 miles north of Portland. It is directly opposite the city of Waterville, and the buildings of Colby College look across the river upon the artesian area to be described.

The Hollingsworth & Whitney Company, on whose property the flowing well is, has drilled seventeen wells in the last nineteen years. The first series was drilled in 1899 and is described in Water Supply Paper 223.[1] At this time there were seven wells from 110 to 125 feet deep.[2] These are said to have gradually filled with sand, until in 1906 they were about 90 feet deep. At this time they were abandoned because of insufficient supply for the purpose desired and river water substituted.

Since the paper referred to above was written, and especially in the last five years, the company has shown renewed interest in drilled wells. In 1913–'14 four wells were drilled with depths of 240, 250, 277 and 260 feet; in 1916 two, with depths of 306 and 269; in 1917 most of the wells drilled in 1899 were again brought into use; and in 1918 four wells were added which were 315, 286,308 and 317 feet in depth. The total water supply of these wells, by pumping, is estimated at 275,000–300,000 gallons in 24 hours. The casing, in most instances at least, is six-inch. The water is utilized for making acid used in the manufacture of sulphite pulp.[3]

Successful drilled wells are rather common in the slate area of southern Maine; 88 per cent. of those undertaken furnish at least a gallon a minute according to Clapp.[4] Flowing wells in slate are far less common and when struck seldom furnish over three gallons a minute.[5] Previously to the one described below none were known in Kennebec county and probably none within a radius of over 50 miles. The well 286 feet deep drilled for the Hollingsworth & Whitney Company is 1918 is therefore of special interest since it is a flowing well. A photograph furnished me shows the water flowing from a vertical six-inch casing at a height of about three feet above the ground. This flow, without pumping, was estimated to be about 60 gallons per minute; certainly, as can be seen from the photograph,

[1] "Underground Waters of Southern Maine," by Frederick G. Clapp, with records of deep wells by W. S. Bayley, Washington, 1909.

[2] *Ibid.*, 154.

[3] Data kindly furnished by Mr. George H. Marr, engineer for the Hollingsworth & Whitney Company.

[4] *Ibid.*, p. 61.

[5] *Ibid.*, p. 35.

it is far above the average given by Clapp for wells of this type in Maine. So far as I can learn, no test was made to see how far above the surface the pressure would raise the water. An interesting fact is that the 315-foot well drilled in the same year was a flowing well until the 286-well was drilled; when this began to flow, the other ceased. It would seem, therefore, that these two, at least, have a common joint plane or system of joint planes as their reservoir. This is in spite of the fact that in the later wells care was taken to space the wells a hundred feet or more apart to avoid this very thing.

Conditions adjoining these wells are such that it is not strange that an occasional flowing well should be encountered. The mills are situated on a fragment of a terrace about 80 feet above sea level. Back of them is an abrupt rise of about 80 feet to another terrace. The face of the scarp is of clay, but the slate rises through the terrace at elevations above about 160 feet. Wells drilled in the face of the scarp strike ledge after passing through 10 or 15 feet of clay showing a gradual rise of the slate underneath the terrace[6] as though marking the bank of a pre-glacial valley of more mature development. A small stream flowing down the scarp shows the same feature. This rise of the slate ledge behind the mills offers as favorable conditions as could be expected for a flowing well in a region where the reservoir consists of the joint planes of a comparatively localized area, as is generally considered to be the case in wells of this type.

It may be of interest to mention briefly a well drilled recently for the Waterville Country Club located about four miles west of those just described and in the town of Oakland. This contrasts with the Winslow wells in that it is on the summit of an almost bare slate hill 440 feet high, the highest point for several miles. Yet a well drilled here yielded a little water at 10–15 feet, and a sufficient supply at 147 feet. It was decided to continue to 150 feet, and just before reaching that depth a copious supply was encountered which rises to within 15 feet of the surface.

[6] The present course of the Kennebec River through Waterville-Winslow is between vertical slate walls.

HOMER P. LITTLE

COLBY COLLEGE,
WATERVILLE, MAINE

SCIENTIFIC BOOKS

Principles and Practise of Milk Hygiene. By LOUIS A. KLEIN. Philadelphia and London, J. B. Lippincott Company. 1917. Pp. 320, with 40 illustrations.

The book is intended primarily as a text for students pursuing a course in milk hygiene, but should serve a much broader purpose. It presents a well-balanced and concise résumé of facts which have an important bearing on the production of wholesome milk.

The work of others is drawn upon liberally, rather than the author's own theories and experiences, and parts of the book are replete with valuable references. The subject matter is divided into nine chapters, namely; Physiology of Milk Secretion, Colostrum, Milk, Bacteria in Milk, Milk Defects, Influence of Disease upon Milk, Dairy Farm Inspection, Pasteurization, and Methods of Examining Milk. There is also an appendix of 18 pages on Methods and Standards for the Production and distribution of Certified Milk.

A large part of Chapter VI. is given over to a discussion of tuberculosis of cows and transmission of infection to man through the milk. The theories and experimental facts leading up to the present status of the controversy are illuminating from the standpoint of completeness and organization. The hand of the veterinary pathologist may be seen in the descriptions of symptoms and pathology of bovine diseases, especially of the udder and related organs.

Chemistry and bacteriology also receive their due share of attention. The restricted emphasis put on the bacteriological methods of controlling sanitary milk production will be perhaps somewhat disappointing to those who regard the enumeration of bacteria by the direct microscopic or the plating process as of inestimable value. Correspondingly undue em-

phasis will appear to be placed on inspection, the limitations of which have in very recent years been recognized.

The book is remarkably free from grammatical and typographical error. Furthermore, the good quality of paper, the large bold type and the pleasing cover should make the book a welcome addition to the library of the dairyman, dairy inspector, milk examiner, milk distributer, public health official and others who are at all interested in the field which the author has covered.

Leo F. Rettger

SPECIAL ARTICLES

THE OVIPOSITION HABIT OF GASTROPHILUS NASALIS L.

In a short article recently published in the *Canadian Entomologist,* Vol. L., No. 7, July, 1918, pp. 246–248, entitled "Note on Oviposition of *Gasterophilus nasalis* L.," Dr. C. H. T. Townsend makes the statement that he has observed this species darting at the muzzle of a horse, leaving "whitish eggs with their sharp bases penetrating and adhering in the skin of the upper lip." Unfortunately for the proof of this observation the eggs were lost, but the author states that similar eggs were dissected from the abdomen of the fly. In the same note the author remarks that the egg of *nasalis* "is practically the same size and shape as that of *intestinalis* and that by reason of the moderately pointed anal end it is capable of penetrating tender skin." Dr. Townsend concludes that the attachment of the eggs of *nasalis* to the hairs of the host only happens inadvertently when the fly misses its true mark, namely, the tender skin of the lips.

It is not unlikely that Dr. Townsend may be capable of distinguishing the eggs of *G. hæmorrhoidalis* from those of the other two species by reason of its black color, but it is rather unfortunate that he should say that the egg of *G. nasalis* is of the same size and shape as that of *G. intestinalis.* The eggs are absolutely distinct both as regards shape and attachment to the hair, and the egg of *G. nasalis* is certainly not adapted for the penetration of the host's skin.

Far from the deposition of the eggs of *G. nasalis* on the hairs of the throat being accidental, it has been my experience that this is almost invariable. Occasionally, as many as six to eight eggs have been found on a single hair. The adult fly so far as I am aware, has never been seen to strike at the lips but always at the hairs of the skin between the mandibles and sometimes on the hairs of the cheek.

The eggs of all three species are transversely striated, a fact to which Dr. Townsend probably refers when he remarks on the transversely corrugated structure of the chorion of the egg of *G. nasalis.* But to add that these striations in the case of the latter egg serve to retain the egg in the skin after it is inserted is purely fictitious. It is undoubtedly true that the stalked egg of *G. hæmorrhoidalis* which is invariably found attached to the short hairs of the lips, often appears to penetrate the skin. Repeated examination has shown, however, that the clasping stalk may sometimes enter the hair follicle and thus give the impression that it is actually inserted in the skin.

In summing up, it is my opinion that Dr. Townsend has conceived of his ideas from observations that are quite inaccurate and that in a more detailed study of the habits of botflies he would find *nasalis* never "strikes" at the lips of the horse, and certainly in my experience it has never been known to oviposit there.

A. E. Cameron
University of Saskatchewan

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